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The National Park Service (NPS) has recently constructed several new wastewater treatment facilities at the Yellowstone National Park. These facilities represent a major commitment by the Park Service to ensure that the high quality of water in the Park is not degraded by the presence of man.

To ensure that their new facilities perform as expected, the Superintendent of the Yellowstone National Park requested assistance from the EPA to train Park personnel in process control procedures and to provide performance evaluations of treatment facilities. Specific technical assistance was requested for the nitrification-denitrification facility located at Fishing Bridge. Limited additional assistance was provided at the Old Faithful facility. Two weeks of troubleshooting on-site technical assistance was conducted in August 1976 and extensive follow-up through telephone calls continued for the remainder of the operating season.

(Process) The report describes the recommendations made to improve the process.

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REPORT ON THE PLANT EVALUATION

AT

OLD FAITHFUL WASTEWATER TREATMENT PLANT
YELLOWSTONE NATIONAL PARK, WYOMING

AUGUST 1977

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I. INTRODUCTION

The National Park Service (NPS) has recently constructed several new wastewater treatment facilities at the Yellowstone National Park. These facilities represent a major commitment by the Park Service to ensure that the high quality of water in the Park is not degraded by the presence of man.

To ensure that their new facilities perform as expected, the Superintendent of Yellowstone National Park requested assistance from the EPA to train Park personnel in process control procedures and to provide performance evaluations of treatment facilities. Specific technical assistance was requested for the nitrification-denitrification facility located at Fishing Bridge. Limited additional assistance was provided at the Old Faithful facility. Two weeks of troubleshooting on-site technical assistance was conducted in August 1976 and extensive follow-up through telephone calls continued for the remainder of the operating season.

The intent of this report is to document these technical assistance activities and to provide recommendations to the Park Service relating to the problems that were encountered.

II. SUMMARY AND RECOMMENDATIONS

In response to a request from the Superintendent of Yellowstone National Park, EPA provided assistance to the Park Service in August 1976. The assistance was primarily directed at the nitrification-denitrification facility at Fishing Bridge but some time was also devoted to the Old Faithful wastewater treatment plant.

Observations and process control data obtained at the Old Faithful facility strongly indicated that the high temperature of the wastewater was a critical factor which influenced all phases of operation. It is suspected that nitrification was occurring in the plant (primarily due to the warm sewage) even though the facility was not designed to nitrify. Settleometer tests revealed the formation of extensive gas bubbles which caused excessive floating of sludge in both the settlometer and the clarifier. This gas was probably nitrogen gas, the end product of denitrification.

Operational changes were made in an attempt to both reduce the degree of denitrification in the clarifier and the degree of nitrification in the aeration tanks. These changes showed some promise of improving plant performance but full evaluation of the problem was not possible due to the short time spent at the plant and lack of available data.

The following recommendations are provided to aid the operations staff in optimizing treatment performance.

1. Maximum operator attention is needed during the start-up period to establish a carefully controlled sludge wasting program. The quantity and frequency of sludge wasted may be higher than expected due to the warm sewage temperature.

2. Due to relatively warm sewage temperatures the system may also need to operate at less than design hydraulic detention times. This can be accomplished by not using all of the aeration tanks.

3. The final clarifier should be operated to minimize sludge detention times in order to reduce denitrification.

4. Ammonia nitrogen data should be collected and correlated to the rising sludge problems.

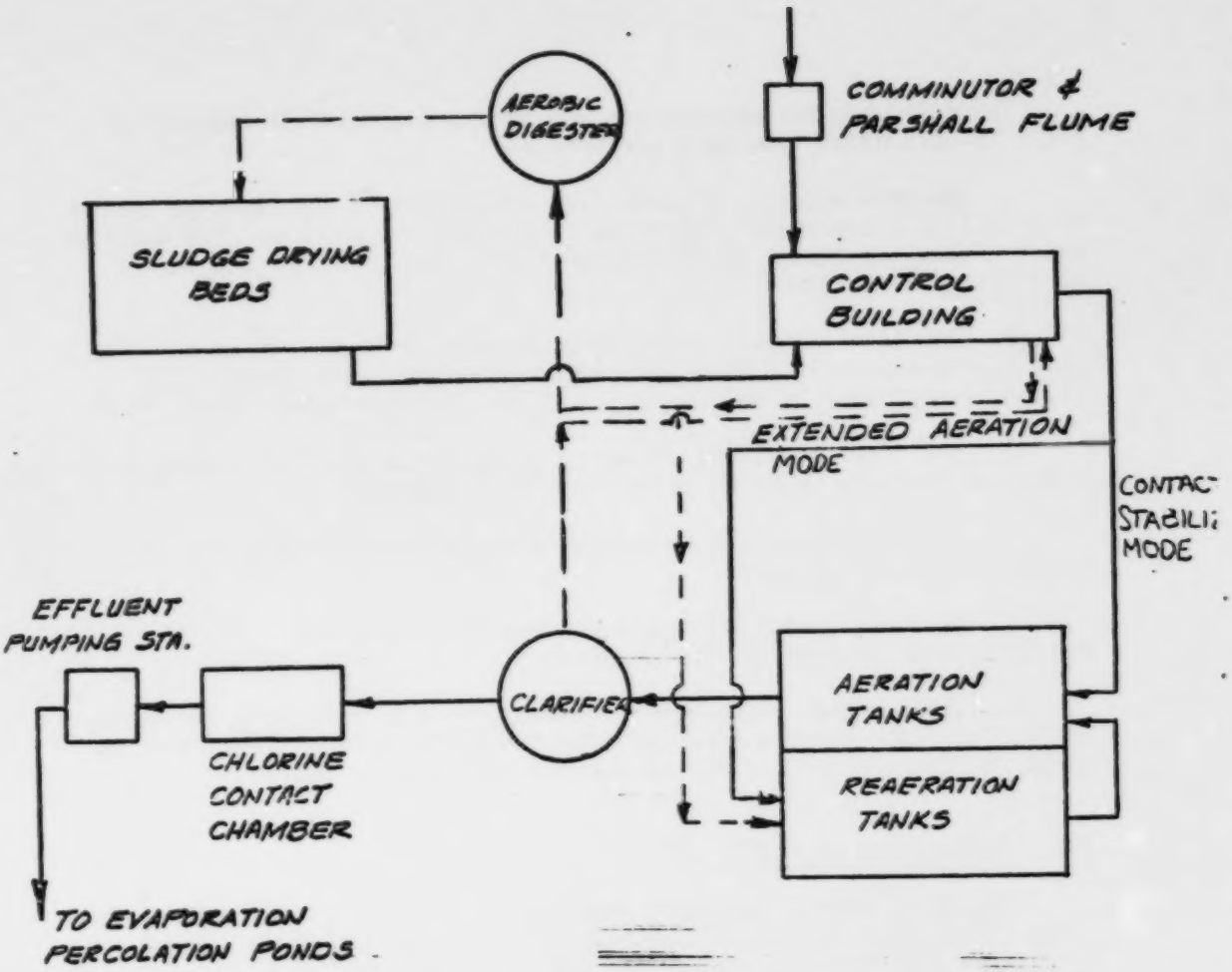
5. Maintain thorough process control tests and data analyses to aid in further process control analyses.

6. Utilize one or more of the reaeration basins as a N_2 stripping basin. This may require some additional pumps, possibly air-lift pumps to redistribute return sludge to appropriate aeration basins.

III. DESCRIPTION OF PLANT

The Old Faithful treatment facility is a 0.51 mgd activated sludge plant. The plant has the flexibility of operating in a conventional or contact stabilization mode. Contact stabilization is the primary mode of operation. Figure 1 is a schematic flow diagram of the facility and Table I shows the various units with their physical dimensions.

The sewage enters the plant and passes through a communitor and parshall flume prior to entering a wet well. The sewage is then pumped from the wet well to the contact stabilization tank. Mixed liquor from the contact tank flows to the secondary clarifier. The solids which settle to the bottom of the clarifier are returned to the reaeration basin. Reaerated sludge then passes to the contact tank. Scum and waste activated sludge are pumped to the aerobic digester. Secondary effluent flows over the clarifier weir to a chlorine contact tank and then is pumped to the evaporation/percolation ponds.



TREATMENT PROCESS SCHEMATIC

FIGURE I - Old Faithful WWTP

TABLE I - Principal Design Criteria of the Old Faithful WWTP

Design Population	5,500
Average Flow-MGD	0.51
Peak Flow-MGD	1.2
Biochemical Oxygen Demand-(5 Day)-lbs./day	1,378
Suspended Solids-lbs./day	1,350
Emergency Storage (existing septic tank)-Gal.	48,000
Secondary Treatment Unit	
Control Building Pumping Station	1 at 300
Number & Capacity of Pumps-GPM	2 at 900
Contact Aeration Section	
Number of Tanks	2
Dentention time at design flow-hours	1.5
Air Supply-CFM	526
Volume, each tank - FT^3	4,356
Reaeration Section	
Number of Tanks	4
Detention time at design flow hours	8.2
Air Supply-CFM	975
Volume, each Tank - FT^3	5,953
Sludge Recirculation Pumps-GPM	2 at 400
Clarifier	
Number	1
Overflow Rate-Gal. sq. ft./day	
Design	400
Peak	950
Diameter - feet	40
Sidewater Depth - feet	9
Volume - FT^3	11,309
Aerobic Digester	
Diameter - feet	40
Sidewater Depth - feet	12
Volume - FT^3	15,072
Air Supply-CFM/min./1000 cu. ft. volume	30
Chlorine Contact Unit	
Type of Chlorination	Gas
Detention time at design flow/hours	0.79
Volume - FT^3	2,880
Chlorine feed rate-lbs./day max.	200
Effluent pumps-number & GPM	2 at 900

Sludge Beds	
Area - Sq. feet	10,500
Area/Population Equiv. - sq. feet	1.9
Aeration Blowers	
Number & Capacities - CFM	1 at 1,500 1 at 750 1 at 450 1 at 220

Percolation - Evaporation Ponds

Total Area - Acres	3.77
Number of Cells	6
Number of Sealed Cells	1
Total Volume - 670,000	

IV. OPERATION EVALUATIONS

A. Prior to Technical Assistance:

On July 10, 1976, the plant was put into operation. Data shows that initial start-up of the facility was quite rapid. The desired amount of solids in the system was achieved in less than two weeks. Normally, it takes more time for most plants to achieve full operating status. This was believed to be the result of the high temperature sewage which was received by the plant. Influent temperature ranged from 23.5 to 25 degrees Centigrade. Considerably higher microorganism activity would be expected at these temperatures.

During the start-up of the facility, the plant was operated in the plug flow mode. Process control graphs showed that in approximately a week and a half (July 10, 1976) the plant contained a good quality sludge. However, during the latter part of July, sludge quality started to deteriorate. The process control graphs showed that the sludge in the settleometer would rise in less than sixty minutes, an indicator or poor quality sludge. Analyses of the available data revealed that solids wasting was deficient. By not wasting any solids, solids became overoxidized and resulted in the problem of rising sludge. It was also suspected that nitrification was occurring in the aeration tank and that significant denitrification was occurring in the final clarifier resulting in rising sludge.

The mode of operation was then changed from plug flow to contact stabilization. The long reaeration detention times, however, seemed to compound the problem of overoxidized sludge. The reaeration time was about 19 hours/day and contact time was approximately 3-4 hours/day.

B. Process Control Assistance:

1. Implementation of Process Control Procedures

The process control procedures implemented were developed by Al West and modified by Region VIII Operation and Maintenance Section staff. The tests consisted of the centrifuge test, dissolved oxygen test, depth of blanket settleometer test, and turbidity test. Following is a brief description of each test.

Centrifuge Test: Samples of the reaeration basin, contact tanks, return sludge and waste sludge were analyzed for suspended solids by the centrifuge. Suspended solids tests were also performed by the analytical balance gooch crucible method to correlate MLSS to percent solids by centrifuge.

Depth of Blanket Test: The depth of blanket test was used for determining the depth of sludge in the final clarifier.

Turbidity Tests: The turbidity test was used to evaluate process performance and to indicate whether the process was improving or deteriorating. Samples were taken from the clearest spot on the final clarifier.

Dissolved Oxygen Tests: This test was used to determine dissolved xoygen levels in the liquid at various places, (aeration basin, return sludge, final clarifier effluent and influent).

Settleometer Tests: Samples were taken of the mixed liquor in the reaeration basin and the contact tank for settleometer tests. The settleometer test was used to observe sludge settling characteristics.

All of these tests with the exception of the settleometer test were performed four times/day. The settleometer test was performed two times/day. The tests results along with other information were used in calculation to make up process control graphs and to make process control adjustments.

2. Process Modification

Evaluation of the facilities during the week of August 4, 1976 revealed that some adjustment had to be made to achieve equal flow and solids distribution in the two contact tanks. One contact tank was receiving more solids and more flow due to the location of the influent pipe and the flow splitter gates. The flow from the reaeration tanks pass over weirs and enter a channel where it contacts the raw sewage. A 90 degree turn in the channel brings the mixture to the contact tank. This condition resulted in most of the solids and the flow bypassing the naearest aeration tank.

After discovering this condition, alterations were made so the raw sewage and the reaeration tank effluent were well mixed before approaching the contact tank. Gate valves were adjusted to build up the head in the channel just before the mixed liquor and sewage entered the contact tank. The flow split was then regulated by the uniform head and similar orifices created by each gate valve.

3. Operational Assistance

Further evaluation of the facility confirmed that the system contained an old sludge. From observation of the settleometer test it was felt that significant denitrification was taking place in the final clarifier. Sludge was floating to the top of the settleometer within forty minutes after settling. The initial action taken was to establish a wasting program.

Follow-up on Monday morning, August 9, 1976, indicated that conditions had not improved. The surface of the final clarifier was covered with scum. The solids in the settleometer, after settling, rose to the surface in less than forty minutes. Effluent turbidity was high due to cloudy water and the solids which floated to the surface of the clarifier.

Wasting was again increased and two reaeration basins were taken out of service to reduce sludge reaeration time. Raw sewage was split so that a portion of the flow entered the remaining two reaeration basins as well as the contact basins creating a step-feed operation. Flows were adjusted periodically to maintain equal distribution of flows to each basin. Flow meters were not available for each basin so a bucket and stop watch were used for measuring flow. Approximately three days later, process control tests revealed significant improvements in sludge quality. The sludge in the settleometer was beginning to stay on the bottom of settleometer longer, burbidity was improving and the appearance of the aeration basin and clarifier was improving. The process control tests and graphs showed that the quality of operation was improving along with plant effluent quality. On Friday, August 13, 1976, the turbidity was down to six JTU's and the trend charts indicated that the plant was heading in the right direction. Figure II is a graph showing effluent settled turbidity FTU and shows the best result, a 1.9 JTU on August 16, 1976.

Subsequently, however, the turbidity started to rise. On-site assistance had ended but telephone communications was continued. The operator reported that he believed the plant had been hit with some type of toxic material which upset the process. Sludge started to rise in the clarifier again and turbidity in the effluent started to rise.

The operator reported that at times the surface of the clarifier would be clear, but at other times the surface would be covered with sludge. The operator also reported that he saw evidence of an excessive amount of grease entering the treatment system. This situation continued until the facility was shut down for the winter.

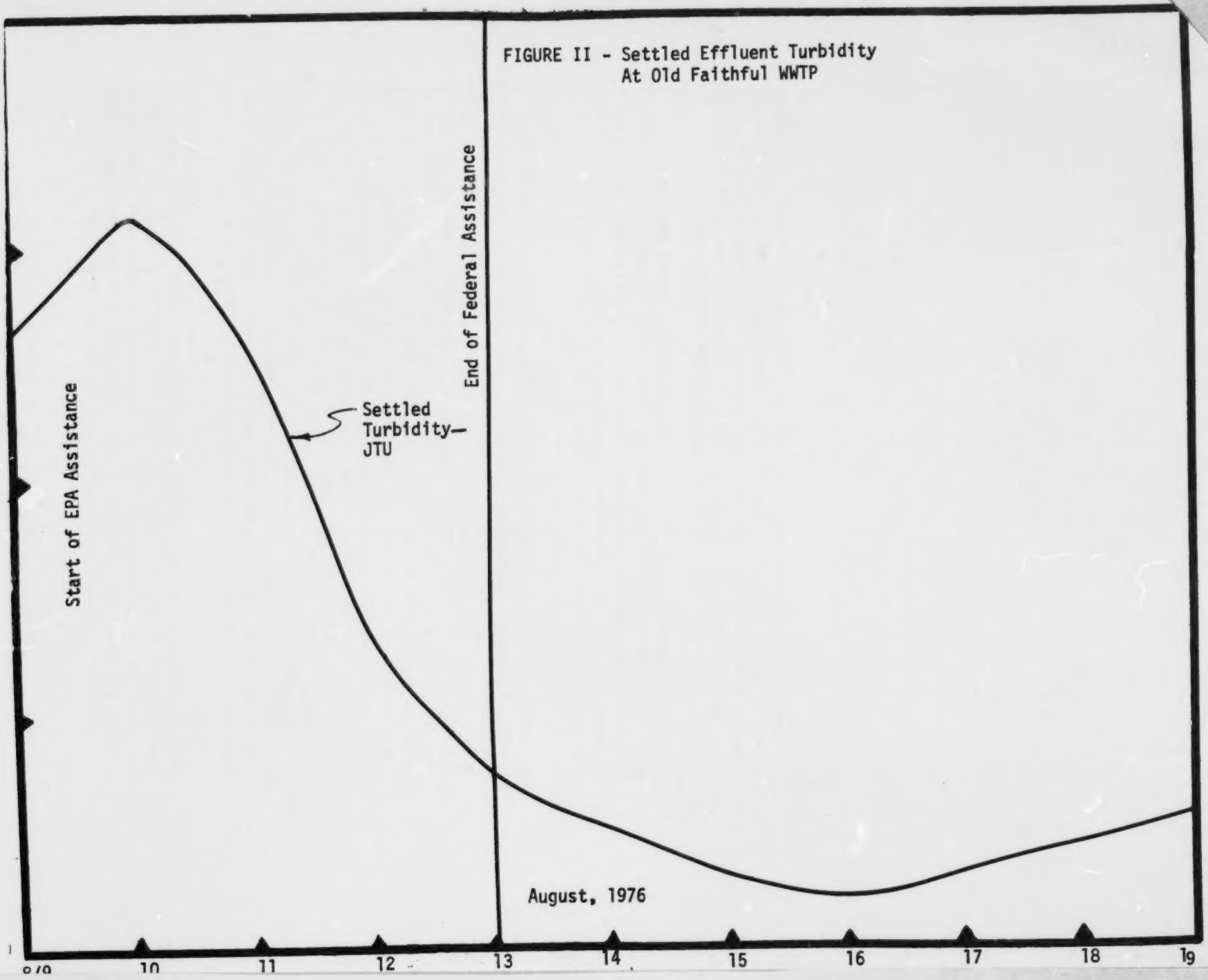


FIGURE II - Settled Effluent Turbidity
At Old Faithful WWTP